



**PRIORITIZING MOBILITY AIR FORCE AIRBORNE INFORMATION EXCHANGE
REQUIREMENTS**

GRADUATE RESEARCH PAPER

Cody A. Vanderpol, Major, USAF

AFIT-ENS-MS-22-J-057

**DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY**

Wright-Patterson Air Force Base, Ohio

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GRADUATE RESEARCH PAPER

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the
Degree of Master of Science in Operations Management

Cody A. Vanderpol, MS

Major, USAF

June 2022

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Cody A. Vanderpol, MS
Major, USAF

Committee Membership:

Jeffery D. Weir, PhD
Chair

Abstract

Over the last decade, the Air Force and Air Mobility Command (AMC) produced numerous studies, campaign plans, vision and scope documents, operating concepts, and roadmaps stating the need for improved Mobility Air Forces (MAF) Situational Awareness (SA) capabilities and global secure Command and Control (C2) Communications. Recently the Joint Community is developing what it refers to as Joint All Domain Command and Control, and the Air Force has published doctrine describing Agile Combat Employment (ACE) and the associated Mission Type Orders (MTO). The fundamental issue that both the Air Force and Joint Community is wrestling with is Mission Assurance. This research takes the comprehensive listing of airborne Information Exchange Requirements (IER) found in the AMC Global Secure Command and Control Air to Ground Communications Capabilities Based Assessment and seeks to characterize and prioritize them with regards to Mission Assurance. An IER Framework is presented to help inform the communication gaps and describe what type of decisions are required during MTO execution. Mission planners can build branches and sequel to execute Commander's Intent based on potential degradation of communications, depending on the anticipated environment. This specifically assists in Risk Guidance based on what type of decisions the Aircraft Commander may have to execute. The communication requirements in the "SA Data" category are the most critical because MAF aircraft must execute ACE operation in concert with other aircraft. Therefore, Mission Assurance, as defined as the execution of Mission Essential Functions, most closely correlates to SA information exchanges.

Acknowledgments

First and foremost, I would like to thank my sponsor, Col Brad “Roto” Rueter for giving me the opportunity sink my teeth into this topic, and for helping the “comm guy” to better understand some of the more nuanced aspects of operations. His insight and perspective helped shape and steer my heading on this journey. Special thanks to my advisor, Dr. Jeffery Weir for his wise council and guidance along the way to get me across the finish line. I especially appreciate the staff in Air Mobility Command A3, A5, and A6 for providing relevant products along with their helpful experiences. Thanks as well to the one and only Ms. Pamela Bennett-Bardot for her premier research support at the U.S. Air Force Expeditionary Center library. Thanks most of all to my incredible spouse and best friend, for her constant support and encouragement, and for always reminding me of the bigger picture and what really matters.

Cody A. Vanderpol, Major, USAF

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PRIORITIZING MOBILITY AIR FORCE AIRBORNE INFORMATION EXCHANGE REQUIREMENTS

I. Introduction

General Issue

Commanders at every echelon require quality, fused, and shared information in order to conduct predictive analysis and collaborative decision-making, thus producing seamless planning and execution. Over the last decade, the Air Force and Air Mobility Command (AMC) has produced numerous studies, campaign plans, vision and scope documents, operating concepts, and roadmaps stating the need for improved Mobility Air Forces (MAF) Situational Awareness (SA) capabilities and global secure Command and Control (C2) Communications. Specifically, the 2010 and 2014 MAF C2 Functional Needs Analyses and 2011 AF C2 Capability Assessment Team identified gaps in air mobility ground and platform C2 systems and communications connectivity (AMC/A5 2016).

The National Defense Strategy published in 2018 refocused the US military from sustaining combat operations in low-end fights to a high-end fight with a near-peer competitor (SECDEF, 2018). In 2020, the Joint Staff Joint Capabilities Board (JS/JCB) validated the Initial Capabilities Document (JS/JCB, 2020) for MAF Global Secure Command and Control Airborne and Ground Communications (AMC/CV, 2014). Specifically, the JCB emphasized AMC's urgent need to improve the MAF's ability to integrate with Combat Air Forces, Space Forces, Special Operations Forces, Global Strike Forces, and joint and coalition forces within a complex battlespace. It focuses on two specific capability gaps. First, to provide air and ground forces with secure Line of

Sight (LOS) and Beyond Line of Sight (BLOS) connectivity; and second, to provide capabilities to connect the Air Operations Center (AOC) directly with both air and ground forces in all theaters of operation (JS/JCB, 2020). The problem extends even beyond the United States, as future operations will require multi-nation communications from the theater of operations back to command centers (Rupar, et al, 2020).

In parallel with the recent efforts of the Air Force, the Joint Community has approached the problem set through the Joint All Domain Command & Control (JADC2) initiative. From the unclassified summary of the strategy, “Joint Force Commanders require secure, worldwide communications networks with sufficient speed and bandwidth to meet National Command Authority and Combatant Command warfighting needs” (JADC2 Strategy, 2022). One of the five Lines of Effort is dedicated to address the transport infrastructure deficiencies across the ecosystem, and provides what it calls essential minimum features necessary for a continuous C2 capability. The strategy concludes that the use of an enterprise-wide, holistic approach for implementing C2 capabilities is urgently needed to gain and maintain information and decision advantage against global adversaries.

The fundamental issue that both the Air Force and Joint Community wrestle with is Mission Assurance: “a process to protect or ensure the continued function and resilience of capabilities and assets - including personnel, equipment, facilities, networks, information and information systems, infrastructure, and supply chains - critical to the performance of DoD Mission Essential Functions in any operating environment or condition.” (Carter, 2012). Mission Assurance and the realms of Information Technology (IT) are inextricably linked. “Too many people perceive IT as

only a mission enabler, but in fact, IT is a critical mission dependency” (Heinbockel, et al, 2010). The Air Force has recently taken a new approach to Mission Assurance known as Agile Combat Employment (ACE). According to Air Force Doctrine Note (AFDN) 21-1, ACE is “a proactive and reactive operational scheme of maneuver executed within threat timelines to increase resiliency and survivability while generating combat power throughout the integrated deterrence continuum” (Brown, 2022).

The goal of ACE is to increase Mission Assurance by shifting operations from large, centralized bases to distributed smaller nodes in order to create targeting dilemmas for the adversary. The key ingredient for ACE requires “communications packages that are mobile, survivable, secure, and sustainable across the electromagnetic spectrum to provide personnel access to DOD networks and voice services in a Denied, Degraded, Intermittent, and Limited (D-DIL) environment” (Brown, 2022). The AMC Strategy published in March 2022 also highlights the significance of Mission Assurance when it defines the end state as “mobility forces able to communicate...inside the first island chain and anywhere else” (Minihan, 2022). The only way to achieve this end state is developing a resilient and robust Primary, Alternate, Contingency and Emergency (PACE) plan for aircraft communications capabilities.

Problem Statement

Due to the current limitations of communications capabilities on MAF aircraft, Mission Assurance requires deliberate planning in order to account for a wide variety of contingencies in the event communication is degraded. Based on the existing body of work qualitatively defining airborne communications requirements, can a priority be

established to develop a PACE plan to increase Mission Assurance in support of operations across a range of environments from permissive to highly contested?

Research Objectives

Objective 1: Characterize the data exchange requirements described in the Capabilities Based Assessment and assign priorities.

Objective 2: Analyze what is needed in order to characterize Mission Assurance for airborne communications systems in support of Agile Combat Employment and Mission Type Orders.

Research Focus

This research is focused on the airborne communications requirements for MAF aircraft. It specifically looks at C-17 and KC-135 aircraft to represent the airlift and air refueling activities of AMC. The research further focuses on specific information exchanges between MAF aircraft and C2 centers. It takes the perspective of data as a commodity to highlight the significance of selecting what information to share depending on the environment.

Methodology

Utilizing attributes already included in the AMC body of work, each Information Exchange Requirement (IER) is prioritized based on time requirements and security constraints. Priority is characterized as either synchronous or asynchronous communication. Next the IERs are binned into a framework to inform risk acceptance and mitigation in support of Mission Type Orders (MTO). Finally, the framework is analyzed based on significance to Mission Assurance and ACE.

Assumptions/Limitations

The primary assumption is that communications capabilities will degrade in a contested environment, and the most significant limitation is the lack of data available on current information exchanges. The IERs can be characterized and prioritized, but until data is available to analyze, a relevant model for system requirements cannot be developed. An additional limitation on the research is the selection of aircraft to include. The focus is on C-17 and KC-135 aircraft, but the IERs apply to other airlift and tanker aircraft as well. The research did not include any aircraft outside of the mobility enterprise.

Implications

Data must be viewed as a commodity, what data is shared over what transmission medium at what time provides decision advantage to leaders at all levels. Therefore prioritizing information exchange requirements helps optimize PACE plans to determine what systems are utilized to share information. Decision Advantage for Mobility Air Forces requires the ability to provide enhanced situational awareness by having as much access to the right data as possible.

Mission planning is critical to mitigate risk due to the loss of communications during flight. The IER Framework incorporation into Mission planning facilitates discussions for risk guidance based on the anticipated environment by aligning with the scenarios outlined in the AMC MTO primer. SA Data represents the most critical communication requirements when executing MTO. And, Mission Assurance, as defined as the execution of Mission Essential Functions (MEF), most closely correlates

to SA Data.

II. Literature Review

Introduction

Every AMC Commander since 2011 stated and reiterated the requirements for secure BLOS and LOS voice and data on MAF aircraft (AMC/CV, 2014). The requirements for airborne network capabilities on MAF aircraft have grown out of operational mission experience over the last decade. MAF operational missions are critical components of U.S. military capability. Due to their low density, high demand nature, MAF aircraft must be used as efficiently and effectively as possible. BLOS and LOS secure voice and data are vital to MAF operations. In 2016, AMC published a Capabilities Based Assessment (CBA) of the Global Secure Command and Control Airborne and Ground Communications (GSC2AGC) in an effort to formally define capability requirements, identify gaps and their associated risks. The CBA incorporated the previous body of work supporting GSC2AGC. Shortly following the CBA, AMC updated the GSC2AGC roadmap. In parallel, the Joint Community has published the JADC2 Strategy in order to codify the plan to improve the global communications infrastructure across the DoD in order to achieve and maintain decision advantage at the point of need. Tangentially related to all of these efforts is the recently published AFDN 1-21 on Agile Combat Employment (ACE). The connective tissue between communications infrastructure requirements and ACE is the concept of Mission Assurance.

The body of work thus far can be binned into six major areas: 1) Operating Environment; 2) Functional Mission Areas and associated Communications Needlines;

3) Qualitative Information Exchange Requirements; 4) JADC2; 5) ACE; and 6) Mission Assurance.

Operating Environment

MAF aircraft operate globally with communications connectivity requirements to exchange secure voice and data with MAF C2 agencies. The right C2 and SA information must flow between C2 agencies and MAF aircraft at the time of need. The operating environment spans the spectrum from Permissive to Contested and Highly Contested. A permissive environment allows routine operations with negligible resistance. The environment transitions to contested when an adversary interferes with operations in such a way that specific actions are required to mitigate the threat. A highly contested environment requires advanced warfighting capabilities to create desired results (AMC/A5, 2016). Figure 1 below depicts the spectrum of the operational environment.

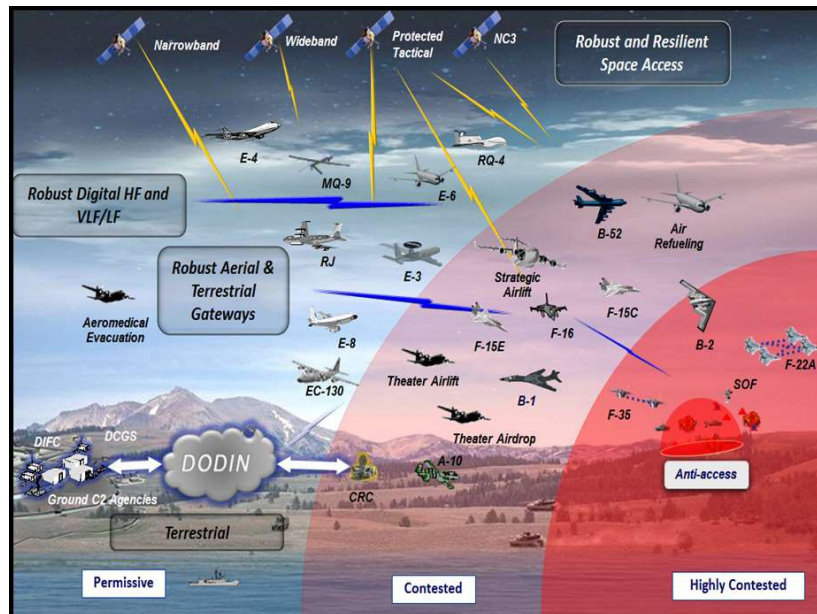


Figure 1 MAF Operating Environment (AMC/A5, 2016)

Functional Mission Areas and Communication Needlines

MAF aircraft operate across three functional mission areas: airland, airdrop, and air refueling. Airland and airdrop missions support the movement of passengers and cargo from one location to another, the key difference being delivery on the ground after landing or released from the air. Due to the similarities in mission areas, both airland and airdrop missions have similar information exchange requirements. The aircraft used to support airland and/or airdrop missions for this research is the C-17. Figure 2 below contains the information exchange needlines to support these missions.

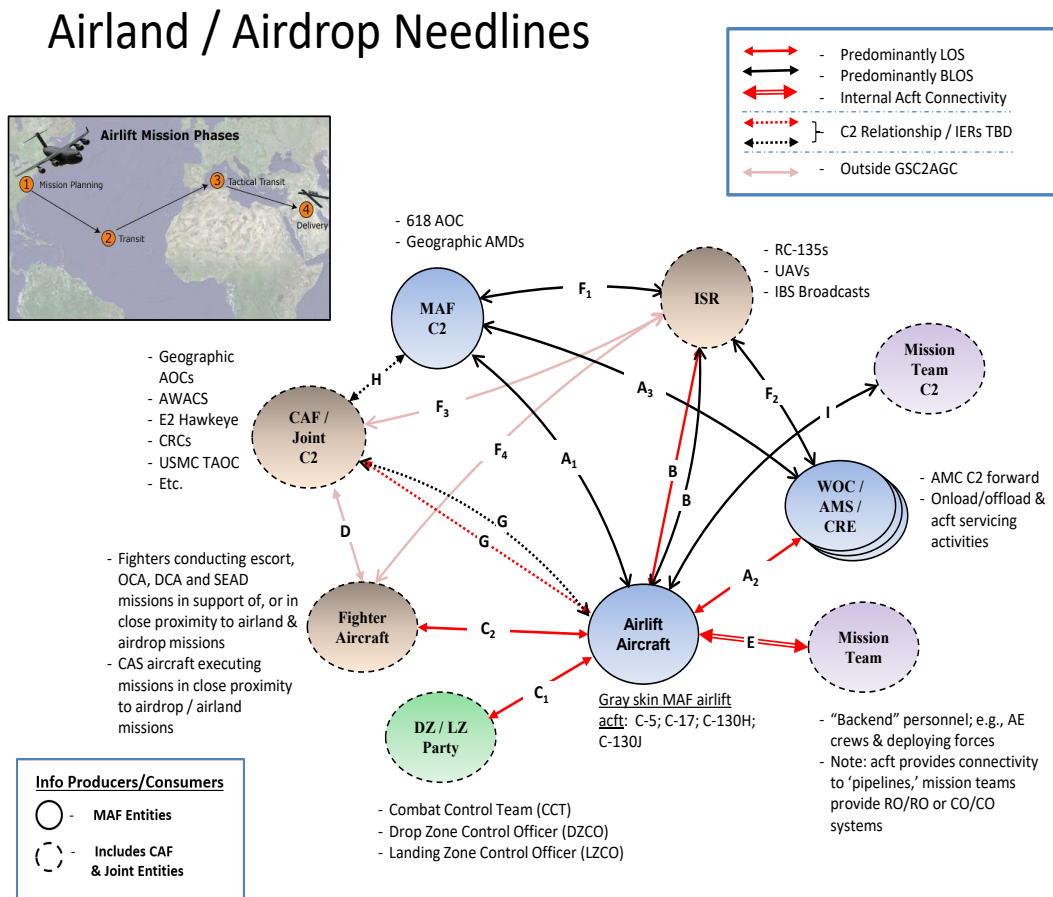


Figure 2 Airland / Airdrop Needlines (AMC/A5, 2016)

Air refueling missions vary in support from homeland defense sorties over the continental United States to providing bridging support for aircraft deploying between theaters and over international waters, to even supporting activities in contested and highly contested environments. The aircraft used to execute air refueling missions for this research is the KC-135. Figure 3 below shows the information exchange needlines for these missions.

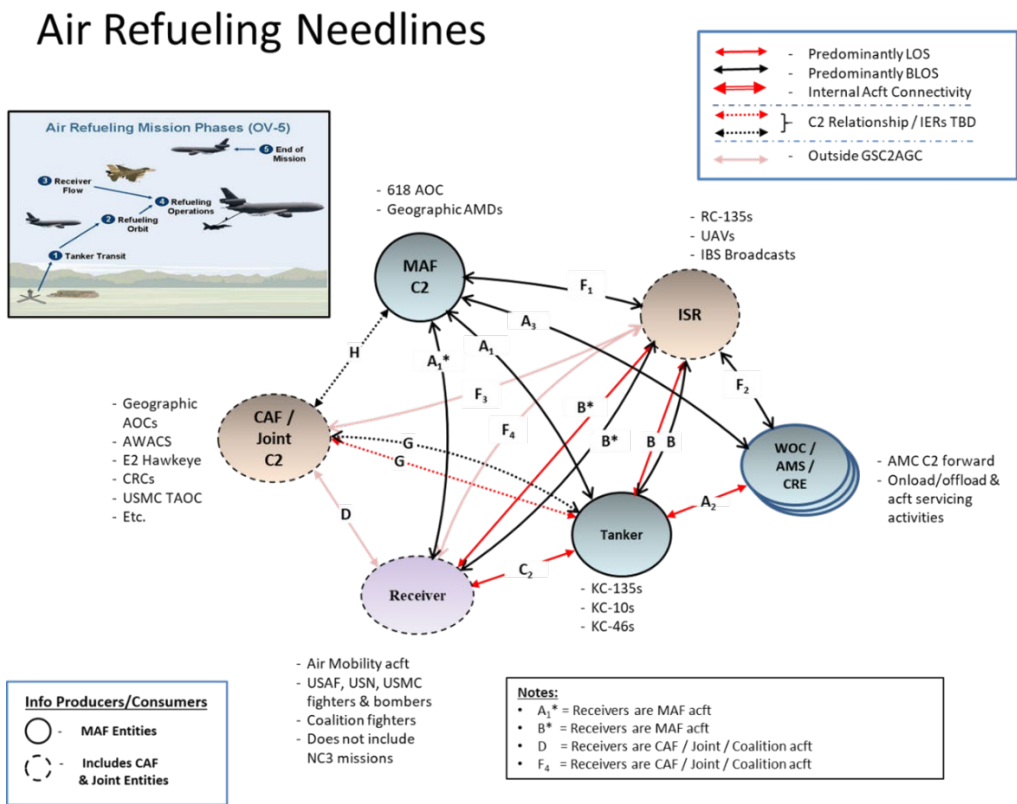


Figure 3 Air Refueling Needlines (AMC/A5, 2016)

Qualitative Information Exchange Requirements

Once the information exchange needlines are established, specific information exchanges can be assigned to each of them based on the different environments and

conditions. The CBA pulled the required information exchanges predominantly from the GSC2AGC Operating Concept (Selva, 2013), the Secure Airborne Communications Vision and Scope 5.1.0 (AMC/A6, 2011), and the United States Air Force Combat Cloud Operating Concept (Lester, 2016). Other documents were included in the review, but did not suggest any information exchange requirements beyond what the three listed above dictated (AMC/A5, 2016). Based on the review, the CBA identified 29 IERs that represent both C2 and SA data that the MAF aircraft must exchange internally and with partners. Each IER focused on what information needs to be exchanged and when it needs to be protected and secured based on the environment.

Joint All Domain Command and Control

Steady increases in the amount of data and information in all domains requires implementation of advanced sensing methods and information management technologies to enable improved information collection in the operational environment. This data and information sensor ecosystem exploits remote sensors, intelligence assets, and open sources to sense and simultaneously integrate information from and within all domains to enable the Joint Force Commander to achieve information and decision advantage.

"Sense and integrate" is the ability to discover, collect, correlate, aggregate, process, and exploit data from all domains and sources (friendly, adversary, and neutral), and share the information as the basis for understanding and decision-making (JADC2 Strategy, 2022).

Mission Assurance

The focus of decision advantage in the JADC2 strategy continues the efforts of DoD to increase Mission Assurance and adapt to the ever changing operational

environment. “Mission assurance focuses on the protection, continued function, and resilience of capabilities and assets critical to supporting MEFs, rather than the operational execution of DoD missions themselves.” (Carter, 2012). As technology has evolved and provided increased capability to maintain connectivity around the world, the realms of Information Technology and Mission Assurance have grown much more integrated. The integration of IT and Mission Assurance requires careful consideration and prioritization for how aircraft communicate depending on the current threat environment. Communication capabilities may be limited as outlined in the sections above, and mission planning must account for branches and sequels depending on how the operational environment changes through the course of the mission.

Agile Combat Employment and Mission Type Orders

One approach the Air Force has adopted to increase Mission Assurance is Agile Combat Employment. Dispersed locations can complicate adversary planning and provide more options for joint force commanders to generate combat power. Providing the flexibility to rapidly re-route forces and equipment inbound to the theater is critical to successful ACE, and is not possible without resilient communications to function in D-DIL environments. From the recently released Air Force Doctrine Note on ACE, “it is highly expected that elements conducting ACE will lose connectivity with operational C2; therefore it is imperative that units be trained to operate via commander’s intent with limited direction from air operations centers or air component staffs” (Brown, 2022).

The dynamic environment expected during ACE operations requires significantly more distributed decision making than the Air Force has employed previously. The

decision construct is labeled Mission Type Orders (MTO), referring to the more generalized nature of the Commander's Intent rather than rigid and distinct guidance. AMC has published the MTO primer and outlines six pillars to provide clarity on how to conduct operations using MTO. The six pillars include Trust and Relationships, "Bias for Action" Culture, Shared Understanding, Commander Air Force Forces authorities, Airmen Development, and Commander Development. The AMC approach to MTO represents a cultural shift from how Aircraft Commanders (AC) have been trained in the past, to how they will be expected to make more decisions in the future.

The MTO primer provides two types of scenarios when an AC will be required to use best judgement by executing MTO. The first scenario is when a C2 authority is unable to execute MEFs, including but not limited to regular communication with deployed mobility forces. The defining aspect of this scenario is that the C2 element capability is degraded in some way. The second scenario is when deployed mobility forces at any echelon are unable to communicate with a higher level C2 authority (Minihan, 2022). The key delineation in this scenario is that the mobility forces (i.e. aircraft) communication capabilities are degraded in some way. The MTO primer mentions Risk Guidance as a Commander's MTO responsibility, but stops short of describing what the Risk guidance looks like. Of note, the MTO primer defines the significance of a PACE plan specifically referring to the Primary, Alternate, Contingency, and Emergency C2 systems, processes, personnel, and authority needed to perform MEF, connecting nicely into the definition of Mission Assurance.

Summary

In summary, MAF aircraft require globally integrated, secure voice and data capabilities for airborne platforms and ground C2 agencies, enabling interoperable, compatible, and synchronized battlespace awareness and C2 of MAF forces supporting the full spectrum of competition environments. The joint community recognizes the importance of sharing information in future dynamic environments and outlines a strategy to achieve JADC2. The Air Force is focusing on dispersal operations through ACE in an effort to increase Mission Assurance. ACE requires a significant increase in mission planning, to include possible branches and sequels for contingency situations. The MTO primer outlines when to use MTO and some basic considerations, but provides very little detail on what executing MTO will look like.

III. Methodology

IER Consolidation and Characterization

The first step is to combine the IER tables for both Airlift and Air Refueling to comprehensively describe requirements for C-17 and KC-135 aircraft. The original Airlift and Air Refueling IER tables are found in appendix 1. A subset of the Airlift IER table is included below in Table 1.

Table 1 Subset of C-17 IERs

IER	Phase	Description	Data Elements	Producer	Consumer	Needline	Remarks
1	Alft: All	Acknowledgement (indicates a message or order has been received and the receiver will or cannot comply)	• Applicable Message / Order	Airlift acft; Tanker acft; ISR; Receivers; MAF C2; CAF/Joint C2	MAF C2; CAF/Jt C2	A ₁ , A ₂ , A ₃ , B, D, G, H	C2 data
			• Receipt Acknowledged				Both Aircrew/Gnd
			• Will Comply				Both BLOS/LOS
			• Cannot Comply				
		• Rationale (insufficient fuel, etc.)					
2	Alft: All	Air Tasking Order (ATO)	• ATO and Special Instructions (SPINS) Applicable to Air Refueling	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, D, F ₃ , H	C2 data
			• Changes to the ATO				Ground C2
			• Fraggged refueling anchor				LOS or N/A
3	Alft: 4	Airfield Status	• Airfield Identification	MAF C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , C ₁ , D, F ₃ ,	C2 data
			• Operational Status (open / closed)	CAF/Joint C2			Both Aircrew/Gnd
			• Threat Level / Condition (includes Nuclear, Biological, and Chemical (NBC) status and warnings)				Both BLOS/LOS
			• Alternate Airfields				
			• Instructions				

The phases for each are included and the remarks are broken out into new columns. Based on the description and data elements, each IER is characterized as either synchronous or asynchronous in order to describe the priority of the each requirement.

The full combined table is included in Appendix 2. A subset of the combined

IER table is included below in Table 2.

Table 2 Combined and Characterized IERs

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
1	Aift & A/R: All	Acknowledgement (indicates a message or order has been received and the receiver will or cannot comply)	Airlift acft; Tanker acft; ISR; Receivers; MAF C2; CAF/Joint C2	MAF C2; CAF/Jt C2	A ₁ , A ₂ , A ₃ , B, D, G, H	C2 data	Both BLOS/LOS	Synchronous
2	Aift & A/R: All	Air Tasking Order (ATO)	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, D, F ₃ , H	C2 data	LOS	Synchronous
3	Aift: 4 A/R: 5	Airfield Status	MAF C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , C ₁ , D, F ₃	C2 data	Both BLOS/LOS	Synchronous

IER Binning and Prioritization

Now that the IERs are consolidated and characterized, it’s time to parse them out into subsets in order to bin them with similar IERs. The key fields for this analysis are “Producer”, “Consumer”, “Remarks”, and the “Synchronous/Asynchronous” characterization. The “Producer” and “Consumer” defines the conditions referenced in the MTO Primer when to use MTO (Mobility forces at echelon unable to communicate with higher level C2 authorities or C2 Authority unable to execute mission essential functions). The “Remarks” field differentiates between C2 communication and SA communication. The “Synchronous/Asynchronous” field provides the binning of real-time communication requirements versus what can be transmitted or received as conditions permit.

The first selection includes IERs relating only to SA data. The filtered table of 10 corresponding IERs is included below in Table 3. It is significant to note that all of the SA data IERs are characterized as synchronous. It is also significant to note that the majority of the SA data IERs require a LOS communication system type.

Table 3 IERs – SA Data

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
6	Alft: N/A A/R: 2, 3, 4	Tanker/Receiver Link-up & Coordination	Tanker acft; Receiver	Tanker acft; Receiver	B, C ₂ , D, F ₄	SA data	LOS	Synchronous
7	Alft: 2, 3, 4 A/R: 1, 2, 3, 4	Airspace Control and Coordination Measures (routes, engagement zones, Airspace Coordination Areas (ACA, etc.)	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data	Both BLOS/LOS	Synchronous
11	Alft & A/R: All	Flight Routing	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	SA data	LOS	Synchronous
12	Alft: 3, 4 A/R: 2, 3, 4	Friendly Aircraft (aircraft identified as friendly)	CAF/Joint C2; ISR; Individual acft	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2; WOC / AMS / CRE	A ₁ , A ₂ , A ₃ , C ₂ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data	LOS	Synchronous
13	Alft: 3, 4 A/R: 2, 3, 4	Friendly Ground Positions	CAF/Joint C2; ISR	Airlift acft; ISR; MAF C2	B, D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data	LOS	Synchronous
14	Alft: 3, 4 A/R: 2, 3, 4	Ground/Surface Control and Coordination Measures (ground axis of advance, Forward Edge of the Battle Area (FEBA), Forward Line of Own Troops (FLOT), etc.)	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data	LOS	Synchronous
15	Alft: 3, 4 A/R: 2, 3, 4	Hostile Aircraft (aircraft identified as hostile)	CAF C2; ISR	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2	B, D, F ₃ , F ₄ , G, H, I	SA data	LOS	Synchronous
16	Alft: 3, 4 A/R: 2, 3, 4	Hostile/Threat Ground Entity	CAF/Joint C2; ISR; LZ/DZ Party	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₂ , A ₃ , B, C ₁ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data	Both BLOS/LOS	Synchronous
24	Alft: 3, 4 A/R: 2, 3, 4	Unknown/Neutral Aircraft	CAF C2; ISR	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	B, C ₂ , F ₃ , F ₄ , G, H	SA data	LOS	Synchronous
27	Alft: 3, 4 A/R: 2, 3, 4	Air Force Airborne Network / Joint Aerial Layer Network (AFAN/JALN) enhancement	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	B, C ₂	SA data	LOS	Synchronous

The next binning filters all IERs produced by the aircraft (either airlift or tanker) and consumed by a C2 element. This binning represents one of the conditions in the AMC MTO primer (mobility forces at echelon unable to communicate with higher level C2 authorities).

Table 4 IERs – Aircraft to C2 - Synchronous

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
1	Aift & A/R: All	Acknowledgement (indicates a message or order has been received and the receiver will or cannot comply)	Airlift acft; Tanker acft; ISR; Receivers; MAF C2; CAF/Joint C2	MAF C2; CAF/Jt C2	A ₃ , A ₂ , A ₃ , B, D, G, H	C2 data	Both BLOS/LOS	Synchronous
4	Aift: All A/R: N/A	Airlift Msn Status	Airlift acft; MAF C2	Airlift acft; MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Synchronous
5	Aift: N/A A/R: All	Tanker Mission Status	Tanker acft	MAF C2; CAF/Joint C2; ISR; Receivers	A ₃ , A ₂ , A ₃ , B, C ₂ , F ₁ , F ₃ , G, H	C2 data	Both BLOS/LOS	Synchronous
23	Aift: 4 A/R: N/A	Tactical Airdrop/Airland Control	MAF C2; Airlift acft; DZ/LZ Party	MAF C2; Airlift acft; DZ/LZ Party	A ₃ , A ₂ , A ₃ , B, C ₁ , C ₂ , G, H	C2 / SA data	Both BLOS/LOS	Synchronous

IERs in Table 4 represent communications at risk if the aircraft loses connectivity with the MAF C2 element and needs some other mechanism to make a decision due to the synchronous nature of the IER. Each of the IERs in this category contains C2 data and therefore contributes to some form of decision for the aircraft. “Acknowledgement”, and “Mission Status” are relatively benign requirements. The outlier is “Tactical Airdrop/Airland Control”. Branch and sequel formulation during Mission Planning should account for the possibility the aircraft will be unable to communicate with the Drop Zone / Landing Zone party.

Table 5 contains asynchronous IERs produced by the aircraft and consumed by the MAF C2 element. These IERs are important but not urgent. If the aircraft is unable to communicate with MAF C2 elements, this information should be logged locally on the aircraft and reported when communications are reestablished.

Table 5 IERs – Aircraft to C2 - Asynchronous

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
17	Alft & A/R: All	In-Transit Visibility (ITV)	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
18	Alft & A/R: All	Maintenance	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
19	Alft: 1 A/R: 1	On/OffStation Notice	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃ , G, H	C2 data	Both BLOS/LOS	Asynchronous
20	Alft & A/R: All	Passenger	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
21	Alft & A/R: All	Payload	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
22	Alft: 4 A/R: 2, 3, 4	System Status	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft; ISR; Receivers; DZ/LZ Party	A ₁ , A ₂ , B, C ₁ , C ₂ , D, E, F ₃ , F ₄ , G	C2 data	Both BLOS/LOS	Asynchronous
28	Alft & A/R: All	Aircrew Information	Airlift acft; Tanker acft; MAF C2	MAF C2	A ₁ , A ₂ , A ₃ , A ₄	C2 data	Both BLOS/LOS	Asynchronous

The other scenario from the AMC MTO primer that dictates MTO is when a MAF C2 authority is unable to execute mission essential functions. For the purposes of this research, the mission essential function of interest is C2 of aircraft. Table 6 contains the IERs produced by the MAF C2 elements and consumed by aircraft that require synchronous communication. These IERs represent critical information to the aircraft, such as Airfield Status and Flight Hazards. Branches and sequels must be discussed during Mission Planning, to provide the aircraft risk guidance in the event communication is lost with MAF C2 and conditions change.

Table 6 IERs – MAF C2 to Aircraft - Synchronous

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
3	Aift: 4 A/R: 5	Airfield Status	MAF C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , C ₁ , D, F ₃	C2 data	Both BLOS/LOS	Synchronous
9	Aift: 3, 4 A/R: 2, 3, 4	Execute/Terminate Command (used to execute or terminate a plan or action. Includes engagement/abort orders, declaration or termination of hostilities, etc.)	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 data	Both BLOS/LOS	Synchronous
10	Aift & A/R: All	Flight Hazards	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 / SA data	LOS	Synchronous
11	Aift & A/R: All	Flight Routing	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	SA data	LOS	Synchronous
23	Aift: 4 A/R: N/A	Tactical Airdrop/Airland Control	MAF C2; Airlift acft; DZ/LZ Party	MAF C2; Airlift acft; DZ/LZ Party	A ₁ , A ₂ , A ₃ , B, C ₁ , C ₂ , G, H	C2 / SA data	Both BLOS/LOS	Synchronous

Table 7 lists IERs produced by MAF C2 elements and consumed by aircraft with an asynchronous requirement. Both of the IERs in this bin should be discussed at length during Mission Planning in the event that communication is lost during the mission.

Table 7 IERs – MAF C2 to Aircraft - Asynchronous

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
25	Aift & A/R: All	Weather	MAF C2; CAF/Joint C2; Airlift acft; Tanker acft; ISR; Receiver	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , A ₄ , B, C ₁ , D, F ₁ , F ₂ , F ₃ , F ₄ , G	C2 / SA data	Both BLOS/LOS	Asynchronous
26	Aift & A/R: All	Mission Tasking, Planning & Scheduling (MTP&S)	MAF C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , A ₄ , H	C2 data	Both BLOS/LOS	Asynchronous

The only three remaining unbinned IERs represent unique scenarios and should be handled independently. They are included below in Table 8. All three require synchronous communication. IER 2 denotes a change to the Air Tasking Order as directed by a Combat Air Force (CAF) or Joint C2 element. IER 8 is an air to air communication regarding an emergency situation. Possibilities include emergency fuel

receiver requests with a directed tactical rendezvous, and in-flight emergency, or even a downed pilot.

Table 8 Unbinned IERs – Unique Scenarios

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
2	Alft & A/R: All	Air Tasking Order (ATO)	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, D, F ₃ , H	C2 data	LOS	Synchronous
8	Alft & A/R: All	Emergency Situation (in-flight emergency, downed pilot, etc.)	Airlift acft; Tanker acft; ISR; Receivers	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , B, C ₂ , D, F ₃ , F ₄ , G, H	C2 / SA data	Both BLOS/LOS	Synchronous
29	Alft & A/R: All	Mission Team Information	Mission Team; Mission Team C2	Mission Team; Mission Team C2	E, I	C2 data	Both BLOS/LOS	Synchronous

These IERs represent critical information exchanges, and all efforts should be made during planning efforts to provide redundant communication capabilities to ensure some level of connectivity for these requirements. In the event that communication is lost, branches and sequels must be discussed during mission planning to provide the aircraft risk guidance on how to proceed. IER 29 refers to Mission Team Information transmitted on behalf of passengers using aircraft communication capabilities. This IER is outside the scope of this research.

Summary

In summary, utilizing attributes included in the CBA, each Information Exchange Requirement (IER) is characterized as either synchronous or asynchronous communication. Next the IERs are binned into a framework to inform risk acceptance and mitigation. The next chapter discusses the significance of the framework in relation to MTO, ACE, and Mission Assurance.

IV. Analysis and Results

Mission Type Orders Significance

The comprehensive list of 29 IERs can be separated in four categories, as shown below in Table 9.

Table 9 IER Framework

SA Data	MAF C2 - Aircraft		Aircraft to MAF C2		Unique Scenarios
Synchronous	Synchronous	Asynchronous	Synchronous	Asynchronous	Synchronous

Two of the four categories correspond directly with the scenarios outlined in the MTO primer. This means the framework can inform the communication gaps to assist decisions required during MTO execution. When a C2 element is degraded, the communication requirements listed in the “MAF C2 – Aircraft” category will be at risk. When the aircraft communication capabilities are degraded the “Aircraft to MAF C2” category will be unavailable. Mission planners can build branches and sequel to execute Commander’s Intent based on potential degradation of communications, depending on the anticipated environment. This specifically assists in Risk Guidance based on what type of decisions the AC may have to execute. The MTO primer mentions Risk Guidance as a Commander’s MTO responsibility, but stops short of describing what the Risk guidance looks like. The IER Framework helps describe the scenarios and can be used to formulate tailored Risk Guidance.

Mission Assurance Relevance

The integration of IT and Mission Assurance requires careful consideration and prioritization for how aircraft communicate depending on the current threat environment.

Mission planning can mitigate significant risk regarding loss of communications highlighted by the “MAF C2 to Aircraft” and “Aircraft to MAF C2”. The “SA data” category represents a more complex level of risk. Each of the communication requirements is produced by a non-MAF element, either CAF C2, receiver aircraft, or some ground element. Each of them requires a LOS communication system. In a contested environment, this group of communication requirements represents some of the most dynamic and unpredictable scenarios. It’s difficult to mitigate all risk through mission planning, because there are too many unknown variables. An additional mitigation method is to provide redundant communication systems for the same requirements, so that if one system is degraded another system can still function. These communication requirements represent the most important in the list and should be incorporated into the PACE plan. They will be vital to the implementation of ACE.

Mission Planning Based on IER Characterization

The AMC MTO primer emphasizes the importance of pre-mission planning, and the IER framework provides a mechanism to discuss risk guidance and outline contingency planning. Some considerations provided in the MTO primer that also fit into the discussion of the IER framework include “AMC always has a dependent customer” and “understand the PACE plan.” Tanker and airlift aircraft don’t exist for themselves, they serve the purpose of transporting vital fuel, supplies, and personnel to the point of need. The “SA Data” category of IERs represents the critical communications with mission partners that aircraft must be able to prioritize. The PACE plan must emphasize the priority of these particular IERs, and be designed to

provide the maximum reliability possible.

Mission Assurance Gap Analysis

Of note, the MTO primer defines the significance of a PACE plan specifically referring to the Primary, Alternate, Contingency, and Emergency C2 systems, processes, personnel, and authority needed to perform MEF, connecting nicely into the definition of Mission Assurance. The link therefore between Mission Assurance and communication systems can be boiled down to Commander's Intent. The AF doctrine on ACE states "in situations where communications are degraded and forces lack continuous contact with higher echelon commands, Airmen should execute in alignment with the commander's intent to protect and preserve the force" (Brown, 2021).

Whatever PACE plan exists to support communication requirements, Mission Assurance must be characterized by Commander's Intent so that AC are able to use best judgement to make decisions. This represents the key difference in the IER Framework between the "MAF C2 to aircraft", "aircraft to MAF C2", and the "SA Data". The communication requirements involving MAF C2 are important, but not as time sensitive during ACE operations as the communication requirements in the "SA Data" category because the MAF aircraft must operate in concert with the other aircraft in the local area when it comes to dispersal operation. Mission Assurance, as defined as the execution of MEFs, most closely correlates to SA Data.

Summary

The IER Framework divides the comprehensive airborne communication requirements for tanker and airlift aircraft into four categories and can be used to discuss

risk guidance during mission planning. The “SA Data” category is the most critical with regards to Mission Assurance due to the synchronous communication requirements and the need to operate in concert with other aircraft in the local area. The AF doctrine for ACE states MTOs are designed to convey Commander’s Intent and allow operational commanders to generate combat airpower in a D-DIL environment “Additionally, they should take advantage of emergent opportunities which allow the commander to maintain the initiative, and resolve situations locally based on a commander’s own situational awareness” (Brown, 2022). That doesn’t happen without critical SA of the local area in order to maximize decision advantage.

V. Conclusions and Recommendations

Conclusions of Research

The primary conclusions of this research are as follows:

- Mission planning is critical to mitigate risk due to the loss of communications during flight.
- The IERs for tanker and airlift aircraft can be divided into four basic categories under the IER Framework including “SA Data”, “MAF C2 to aircraft”, “aircraft to MAF C2”, and “Unique Scenarios”.
- The IER Framework aligns with the two scenarios outlined in the AMC MTO primer.
- SA Data are the most critical communication requirements when executing MTO.
- Mission Assurance, as defined as the execution of MEFs, most closely correlates to SA Data.

Recommendations for Action

Incorporate the IER Framework into Mission Planning and discuss risk guidance based on anticipated environment. Specific branches and sequel plans can be developed based on scenarios when communications in each of the four categories in the IER Framework are degraded.

Continue to invest in resilient and redundant communications capabilities for MAF aircraft specifically prioritizing the SA Data category of the IER Framework (i.e. Tactical Data Links). The majority of the communication requirements in the SA

Data category are available via Tactical Data Link, and therefore represent a significant capability increase for MAF aircraft.

Utilize the IER Framework for Common Operational Picture (COP) development to improve SA for MAF aircraft. As JADC2 and associated programs evolve, the IEF Framework can be incorporated into technical requirements to inform COP capabilities.

Recommendations for Future Research

As mentioned previously, the primary limitation of this research is the lack of data on airborne information exchanges. Once data is available, incorporate the framework to determine quantitative requirements for each IER bin. Specifically, analyze the current information exchanges to assign parameters for total bandwidth (BW) and transmission speed, then assign confidence intervals to each of the parameters for the IERs. Finally, provide quantified and prioritized requirements for each of the bins in the IER Framework to help inform future PACE planning. When data is available, the framework can help quantifiably define the communications requirements for each of the bin types across the spectrum of conditions.

Appendix A: C-17 Information Exchange Requirement Table

IER	Phase	Description	Data Elements	Producer	Consumer	Needline	Remarks
1	Alft: All	Acknowledgement (indicates a message or order has been received and the receiver will or cannot comply)	<ul style="list-style-type: none"> Applicable Message / Order Receipt Acknowledged Will Comply Cannot Comply Rationale (insufficient fuel, etc.) 	Airlift acft; Tanker acft; ISR; Receivers; MAF C2; CAF/Joint C2	MAF C2; CAF/Jt C2	A ₁ , A ₂ , A ₃ , B, D, G, H	C2 data Both Aircrew/Gnd Both BLOS/LOS
2	Alft: All	Air Tasking Order (ATO)	<ul style="list-style-type: none"> ATO and Special Instructions (SPINS) Applicable to Air Refueling Changes to the ATO Fragged refueling anchor 	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, D, F ₃ , H	C2 data Ground C2 LOS or N/A
3	Alft: 4	Airfield Status	<ul style="list-style-type: none"> Airfield Identification Operational Status (open / closed) Threat Level / Condition (includes Nuclear, Biological, and Chemical (NBC) status and warnings) Alternate Airfields Instructions 	MAF C2 CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , C ₁ , D, F ₃	C2 data Both Aircrew/Gnd Both BLOS/LOS
4	Alft: All	Airlift Msn Status	<ul style="list-style-type: none"> Airlift Mission (Cargo, Personnel, Tactical Drop (Airdrop, Direct Delivery), Theater Support, etc) Aircraft Type (C5, C17, C-130 E/H/J, etc.) Airlift Classification (Inter-Theater, Intratheater, Operational Support) Controlling Unit Number of Aircraft Position reporting Estimated Time of Arrival (ETA) Block-in, Block-out; Takeoff; and Arrival Report aircraft is diverting to another operating location, which may be an air event location, such as air refueling track, drop zone, etc. This includes providing a reason for diverting, such as maintenance, emergency airdrop, unplanned air refueling, etc Report mission status. This includes advising of early/late estimated times of departures or arrivals; reporting reason for delayed departure; and reason for delayed arrival 	MAF C2 Airlift acft	Airlift acft; MAF C2	A ₁ , A ₂ , A ₃	C2 data Both Aircrew/Gnd Both BLOS/LOS
5	A/R: All	Tanker Mission Status	<ul style="list-style-type: none"> Tanker Mission (SIOP, Global Attack Support, Theater Support, etc) Tanker Type (KC-10, KC-135, KC-46, etc) (boom or drogue capable) Number of Tankers Number of Receivers Type of Receivers (B-2, F-15, F-16, A-10, UAV, etc) Position reporting Block-in, Block-out; Takeoff; and Arrival Estimated Time of Arrival (ETA) Schedule / Flow of Receivers Primary / Secondary Radio Frequencies Air-to-Air TACAN Beacon Boom Interphone Block and Refueling Altitude Air Refueling Control Time Air Refueling Initial Point Exit Point, etc. Report aircraft is diverting to another operating location, which may be an air event location, such as air refueling track, drop zone, etc. This includes providing a reason for diverting, such as maintenance, emergency airdrop, unplanned air refueling, etc Report mission status. This includes advising of early/late estimated times of departures or arrivals; reporting reason for delayed departure; and reason for delayed arrival 	Tanker acft	MAF C2; CAF/Joint C2; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, C ₂ , F ₁ , F ₃ , G, H	C2 data Both Aircrew/Gnd Both BLOS/LOS

6	A/R: 2, 3, 4	Tanker/Receiver Link-up & Coordination	<ul style="list-style-type: none"> Friendly aircraft data (IER 12) 	Tanker acft; Receiver	Tanker acft; Receiver (Monitor: MAF/C2; CAF/Joint C2; ISR)	B, C ₂ , D, F ₄	SA data
			<ul style="list-style-type: none"> Tanker Status (IER 22) Fuel Requested Vectoring / Holding instructions Receiver's unit, tail number, MDS, etc.; tanker/receiver identification; and emergency refueling rendezvous Receiver or tanker status 				Platform/Aircraft LOS
7	A/R: 2, 3, 4	Airspace Control and Coordination Measures (routes, engagement zones, Airspace Coordination Areas (ACA), etc.)	<ul style="list-style-type: none"> Identification / Name Type 	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data Both Platform/Gnd Both BLOS/LOS
			<ul style="list-style-type: none"> Establishing / Controlling Unit Effective Time(s) Location Size Maximum Altitude Minimum Altitude Restrictions Instructions Tactical arrival/SPIN procedures Special use airspace De-confliction information 				
			Additional Items unique to A/R:				
			<ul style="list-style-type: none"> Route Type (Track or Anchor) Air Refueling Initial Point (ARIP) Air Refueling Control Point (ARCP) Air Refueling Control Time (ARCT) Air Refueling Exit Point (AR EXIT PT) Anchor Point Minimum Refueling Altitude Maximum Refueling Altitude Receivers Holding/Orbit Point 				
8	A/R: All	Emergency Situation (in-flight emergency, downed pilot, etc.)	<ul style="list-style-type: none"> Type of Emergency Location 	Airlift acft; Tanker acft; ISR; Receivers	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , B, C ₂ , D, F ₃ , F ₄ , G, H	C2 / SA data
			<ul style="list-style-type: none"> Emergency receiver fuel requests directed tactical rendezvous outside the fragged tanker anchor...and closest clear area Assessment Intentions 				Both Platform/Gnd Both BLOS/LOS
9	A/R: 3, 4	Execute/Terminate Command (used to execute or terminate a plan or action. Includes engagement/abort orders, declaration)	<ul style="list-style-type: none"> Plan or Action Command (i.e. Cleared Hot, Continue Dry) Instructions 	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 data Both Platform/Gnd Both BLOS/LOS
10	A/R: All	Flight Hazards (unpublished hazards)	<ul style="list-style-type: none"> Identification Description of Hazard Location Effective Time(s) Instructions 	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 / SA data Both Platform/Gnd LOS
11	A/R: All	Flight Routing	<ul style="list-style-type: none"> Point Identification Point Type Point Location Point Terrain Reference Heading and Distance Route (Connects to IERs 4, 5, 23) Altitude Restrictions Holding Instructions Vectoring Instructions 	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	SA data Both Platform/Gnd LOS
12	A/R: 3, 4	Friendly Aircraft (aircraft identified as friendly)	<ul style="list-style-type: none"> Identification (if different from mission number or call sign – i.e. track number) Mission Number Call Sign Aircraft Type (specific – i.e. B-1B, F-15E, C-17, KC-135, etc.) Number of Aircraft (if reporting for a flight / formation) Location (i.e. PPLI) Heading Speed 	CAF/Joint C2; ISR; Individual acft	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2; WOC / AMS / CRE	A ₁ , A ₂ , A ₃ , C ₂ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data Both Platform/Gnd LOS

13	Aift: 3, 4	Friendly Ground Positions	<ul style="list-style-type: none"> • Identification • Location 	CAF/Joint C2; ISR	Airlift acft; ISR; MAF C2	B, D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data Both Platform/Gnd LOS
14	Aift: 3, 4	Ground/Surface Control and Coordination Measures (ground axis of advance, Forward Edge of the Battle Area (FEBA), Forward Line of Own Troops (FLOT), etc.)	<ul style="list-style-type: none"> • Identification/Name • Type • Establishing/ Controlling Unit • Effective Time(s) • Location • Size • Restrictions • Instructions 	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data Both Platform/Gnd LOS
15	Aift: 3, 4	Hostile Aircraft (aircraft identified as hostile)	<ul style="list-style-type: none"> • Identification (track number, target number, etc.) • Aircraft Type (specific – i.e. MiG-29) • Number of Aircraft (in flight/formation) • Nationality (if multiples are possible) • Location • Altitude • Heading • Speed • Weapons • specific withdrawal headings and altitudes to escape enemy fighter detection or engagement • Real-time Electronic Order of Battle (EOB) and Electronic Warfare (EW) and off-board near real-time threat information • Systems / On-Board Capabilities • Fuel Remaining / Endurance Estimate • Friendlies Targeted (if applicable) • Activity • Intentions / Probable Course of Action 	CAF C2; ISR	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2	B, D, F ₃ , F ₄ , G, H, I	SA data Both Platform/Gnd LOS
16	Aift: 3, 4	Hostile/Threat Ground Entity	<ul style="list-style-type: none"> • Identification • Nationality • Location • Type (i.e. Mobile Units, Troop Concentrations, etc) • Subtype (i.e. SA-8) • Weapons (if not conveyed by subtype) • Weapons range • Electronic capability (i.e. radar, jamming, etc)(if not conveyed by subtype) • Activity • Intentions/probable course of action¹⁴ 	CAF/Joint C2; ISR; LZ/DZ Party	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₂ , A ₃ , B, C ₁ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data Both Platform/Gnd Both BLOS/LOS
17	Aift: All	In-Transit Visibility (ITV)	<ul style="list-style-type: none"> • Payload information • Cargo • Passengers • Equipment 	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft	A ₁ , A ₂ , A ₃	C2 data Both Platform/Gnd Both BLOS/LOS
18	Aift: All	Maintenance	<ul style="list-style-type: none"> • Flying Hours • Number of Landings • LRU Fault Codes • Landing Gear Cycles • Life Usage (on all aircraft components) • Engine trending and diagnostic data • Aircraft structural data (aircraft weight, fuel load, strain gauge readings, etc.) • Fuel Load • Alpha Status (number of faults and fault codes) • Automatically download historical aircraft systems data • Report aircraft condition monitoring information • Transmit aircraft condition information to identify maintenance issues or servicing delays 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data Both Platform/Gnd Both BLOS/LOS
19	Aift: 1	On/OffStation Notice	<ul style="list-style-type: none"> • Mission Number • Status (on or off station) • Effective Time(s) (if not immediate) • Intentions 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃ , G, H	C2 data Ground C2 Both BLOS/LOS

20	Aift: All	Passenger	<ul style="list-style-type: none"> Number of pax Number deplaning at next stop 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data Both Platform/Gnd Both BLOS/LOS
			<ul style="list-style-type: none"> Number of DVs Report actual passenger information. This includes reporting unused capacity (e.g., available seats, litters) 				
							Contributes to ITV
21	Aift: All	Payload	<ul style="list-style-type: none"> Type of cargo Hazardous cargo, if applicable 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data Both Platform/Gnd Both BLOS/LOS
			<ul style="list-style-type: none"> Number of pallets Report actual payload (e.g., cargo, fuel) information. This includes reporting unused capacity (e.g., pallet positions, fuel available for offload) 				
							Contributes to ITV
22	Aift: 4	System Status	<ul style="list-style-type: none"> Total Fuel Destination Reserve Fuel Loiter Mean Fuel Burn Per Hour Equipment/System Status RTB 	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft; ISR; Receivers; DZ/LZ Party	A ₁ , A ₂ , B, C ₁ , C ₂ , D, E, F ₃ , F ₄ , G, H?	C2 data Ground C2 Both BLOS/LOS
			<ul style="list-style-type: none"> A/R unique items: <ul style="list-style-type: none"> Total Fuel Off-Load Available from Tanker(s) (lbs) 				
23	Aift: 4	Tactical Airdrop/Airland Control	<ul style="list-style-type: none"> DZ/LZ Identification DZ/LZ Location New point of impact coordinates DZ/LZ Marking Confirmation and authentication of DZ and drop information Load information in the dynamic tactical area Tactical arrival/SPIN procedures Communications Check Point (CCP) Cleared to Drop Abort Code Type of drop Initiation point Point of impact DZ/LZ size Heading Altitude DZ/LZ elevation DZ winds-threshold DZ ceiling/visibility Time and results of air drop events and mission event information 	MAF C2; Airlift acft; DZ/LZ Party	MAF C2; Airlift acft; DZ/LZ Party	A ₁ , A ₂ , A ₃ , B, C ₁ , C ₂ , G, H	C2 / SA data Both Platform/Gnd Both BLOS/LOS
			24				Aift: 3, 4
<ul style="list-style-type: none"> Number of Aircraft (in flight/formation) Nationality Location Altitude Heading Speed Weapons Systems/On-Board Capabilities Fuel Remaining/ Endurance Estimate Activity Intentions/Probable Course of Action Specific withdrawal headings and altitudes to escape enemy fighter detection or engagement 							

Appendix B: KC-135 Information Exchange Requirement Table

IER	Phase	Description	Data Elements	Producer	Consumer	Needline	Remarks
1	A/R: All	Acknowledgement (indicates a message or order has been received and the receiver will or cannot comply)	<ul style="list-style-type: none"> Applicable Message / Order 	Airlift acft; Tanker acft ; ISR; Receivers; MAF C2; CAF/Joint C2	MAF C2; CAF/Jt C2	A ₁ , A ₂ , A ₃ , B, D, G, H	C2 data
	<ul style="list-style-type: none"> Receipt Acknowledged 		Both Aircrew/Gnd				
	<ul style="list-style-type: none"> Will Comply Cannot Comply Rationale (insufficient fuel, etc.) 		Both BLOS/LOS				
	<ul style="list-style-type: none"> ATO and Special Instructions (SPINS) Applicable to Air Refueling Changes to the ATO Fragged refueling anchor 						
2	A/R: All	Air Tasking Order (ATO)	<ul style="list-style-type: none"> ATO and Special Instructions (SPINS) Applicable to Air Refueling 	CAF/Joint C2	Airlift acft; Tanker acft ; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, D, F ₃ , H	C2 data
	<ul style="list-style-type: none"> Changes to the ATO Fragged refueling anchor 		Ground C2				
3	A/R: 5	Airfield Status	<ul style="list-style-type: none"> Airfield Identification 	MAF C2	Airlift acft; Tanker acft ; ISR; Receivers	A ₁ , A ₂ , C ₁ , D, F ₃	C2 data
	<ul style="list-style-type: none"> Operational Status (open / closed) 		CAF/Joint C2	Both Aircrew/Gnd			
	<ul style="list-style-type: none"> Threat Level / Condition (includes Nuclear, Biological, and Chemical (NBC) status and warnings) Alternate Airfields Instructions 			Both BLOS/LOS			
	<ul style="list-style-type: none"> Airlift Mission (Cargo, Personnel, Tactical Drop (Airdrop, Direct Delivery), Theater Support, etc) Aircraft Type (C5, C17, C-130 E/H/J, etc.) Airlift Classification (Inter-Theater, Intratheater, Operational Support) Controlling Unit Number of Aircraft Position reporting Estimated Time of Arrival (ETA) Block-in, Block-out; Takeoff; and Arrival Report aircraft is diverting to another operating location, which may be an air event location, such as air refueling track, drop zone, etc. This includes providing a reason for diverting, such as maintenance, emergency airdrop, unplanned air refueling, etc Report mission status. This includes advising of early/late estimated times of departures or arrivals; reporting reason for delayed departure; and reason for delayed arrival 		MAF C2	Airlift acft			Airlift acft; MAF C2
4	A/R: All	Airlift Msn Status	<ul style="list-style-type: none"> Airlift Mission (Cargo, Personnel, Tactical Drop (Airdrop, Direct Delivery), Theater Support, etc) 	MAF C2	Airlift acft; MAF C2	A ₁ , A ₂ , A ₃	Both Aircrew/Gnd
	<ul style="list-style-type: none"> Aircraft Type (C5, C17, C-130 E/H/J, etc.) Airlift Classification (Inter-Theater, Intratheater, Operational Support) Controlling Unit Number of Aircraft Position reporting Estimated Time of Arrival (ETA) Block-in, Block-out; Takeoff; and Arrival Report aircraft is diverting to another operating location, which may be an air event location, such as air refueling track, drop zone, etc. This includes providing a reason for diverting, such as maintenance, emergency airdrop, unplanned air refueling, etc Report mission status. This includes advising of early/late estimated times of departures or arrivals; reporting reason for delayed departure; and reason for delayed arrival 		Airlift acft	Both BLOS/LOS			
5	A/R: All	Tanker Mission Status	<ul style="list-style-type: none"> Tanker Mission (SIOP, Global Attack Support, Theater Support, etc) 	Tanker acft	MAF C2; CAF/Joint C2; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, C ₂ , F ₁ , F ₃ , G, H	C2 data
			<ul style="list-style-type: none"> Tanker Type (KC-10, KC-135, KC-46, etc) (boom or drogue capable) 				Both Aircrew/Gnd
			<ul style="list-style-type: none"> Number of Tankers 				Both BLOS/LOS
			<ul style="list-style-type: none"> Number of Receivers 				
			<ul style="list-style-type: none"> Type of Receivers (B-2, F-15, F-16, A-10, UAV, etc) 				
			<ul style="list-style-type: none"> Position reporting 				
			<ul style="list-style-type: none"> Block-in, Block-out; Takeoff; and Arrival 				
			<ul style="list-style-type: none"> Estimated Time of Arrival (ETA) 				
			<ul style="list-style-type: none"> Schedule / Flow of Receivers 				
			<ul style="list-style-type: none"> Primary / Secondary Radio Frequencies 				
			<ul style="list-style-type: none"> Air-to-Air TACAN 				
			<ul style="list-style-type: none"> Beacon 				
			<ul style="list-style-type: none"> Boom Interphone 				
			<ul style="list-style-type: none"> Block and Refueling Altitude 				
<ul style="list-style-type: none"> Air Refueling Control Time 							
<ul style="list-style-type: none"> Air Refueling Initial Point 							
<ul style="list-style-type: none"> Exit Point, etc. 							
<ul style="list-style-type: none"> Report aircraft is diverting to another operating location, which may be an air event location, such as air refueling track, drop zone, etc. This includes providing a reason for diverting, such as maintenance, emergency airdrop, unplanned air refueling, etc 							
<ul style="list-style-type: none"> Report mission status. This includes advising of early/late estimated times of departures or arrivals; reporting reason for delayed departure; and reason for delayed arrival 							
6	A/R: 2, 3, 4	Tanker/Receiver Link-up & Coordination	<ul style="list-style-type: none"> Friendly aircraft data (IER 12) 	Tanker acft; Receiver	Tanker acft; Receiver (Monitor: MAF/C2; CAF/Joint C2; ISR)	B, C ₂ , D, F ₄	SA data
			<ul style="list-style-type: none"> Tanker Status (IER 22) 				Platform/Aircrew
			<ul style="list-style-type: none"> Fuel Requested 				LOS
			<ul style="list-style-type: none"> Vectoring / Holding instructions 				
			<ul style="list-style-type: none"> Receiver's unit, tail number, MDS, etc.; tanker/receiver identification; and emergency refueling rendezvous 				
			<ul style="list-style-type: none"> Receiver or tanker status 				

7	A/R: 1, 2, 3, 4	Airspace Control and Coordination Measures (routes, engagement zones, Airspace Coordination Areas (ACA), etc.)	<ul style="list-style-type: none"> • Identification / Name 	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data
	<ul style="list-style-type: none"> • Type 		Both Platform/Gnd				
	<ul style="list-style-type: none"> • Establishing / Controlling Unit 		Both BLOS/LOS				
	<ul style="list-style-type: none"> • Effective Time(s) 						
	<ul style="list-style-type: none"> • Location 						
	<ul style="list-style-type: none"> • Size 						
	<ul style="list-style-type: none"> • Maximum Altitude 						
	<ul style="list-style-type: none"> • Minimum Altitude 						
	<ul style="list-style-type: none"> • Restrictions 						
	<ul style="list-style-type: none"> • Instructions 						
	<ul style="list-style-type: none"> • Tactical arrival/SPIN procedures 						
	<ul style="list-style-type: none"> • Special use airspace 						
	<ul style="list-style-type: none"> • De-confliction information 						
	<ul style="list-style-type: none"> • Additional Items unique to A/R: <ul style="list-style-type: none"> • Route Type (Track or Anchor) • Air Refueling Initial Point (ARIP) • Air Refueling Control Point (ARCP) • Air Refueling Control Time (ARCT) • Air Refueling Exit Point (AR EXIT PT) • Anchor Point • Minimum Refueling Altitude • Maximum Refueling Altitude • Receivers Holding/Orbit Point 						
8	A/R: All	Emergency Situation (in-flight emergency, downed pilot, etc.)	<ul style="list-style-type: none"> • Type of Emergency 	Airlift acft; Tanker acft; ISR; Receivers	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , B, C ₂ , D, F ₃ , F ₄ , G, H	C2 / SA data
			<ul style="list-style-type: none"> • Location 				Both Platform/Gnd
			<ul style="list-style-type: none"> • Emergency receiver fuel requests 				Both BLOS/LOS
			<ul style="list-style-type: none"> • directed tactical rendezvous outside the fragged tanker anchor...and closest clear area 				
			<ul style="list-style-type: none"> • Assessment • Intentions 				
9	A/R: 2, 3, 4	Execute/Terminate Command (used to execute or terminate a plan or action. Includes engagement/abort orders, declaration or termination of hostilities, etc.)	<ul style="list-style-type: none"> • Plan or Action 	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 data
			<ul style="list-style-type: none"> • Command (i.e. Cleared Hot, Continue Dry) 				Both Platform/Gnd
			<ul style="list-style-type: none"> • Instructions 				Both BLOS/LOS
10	A/R: All	Flight Hazards (unpublished hazards)	<ul style="list-style-type: none"> • Identification 	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 / SA data
			<ul style="list-style-type: none"> • Description of Hazard 				Both Platform/Gnd
			<ul style="list-style-type: none"> • Location 				LOS
			<ul style="list-style-type: none"> • Effective Time(s) • Instructions 				
11	A/R: All	Flight Routing	<ul style="list-style-type: none"> • Point Identification 	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	SA data
			<ul style="list-style-type: none"> • Point Type 				Both Platform/Gnd
			<ul style="list-style-type: none"> • Point Location 				LOS
			<ul style="list-style-type: none"> • Point Terrain Reference 				
			<ul style="list-style-type: none"> • Heading and Distance 				
			<ul style="list-style-type: none"> • Route (Connects to IERs 4, 5, 23) 				
			<ul style="list-style-type: none"> • Altitude Restrictions 				
			<ul style="list-style-type: none"> • Holding Instructions • Vectoring Instructions 				
12	A/R: 2, 3, 4	Friendly Aircraft (aircraft identified as friendly)	<ul style="list-style-type: none"> • Identification (if different from mission number or call sign – i.e. track number) 	CAF/Joint C2; ISR; Individual acft	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2; WOC / AMS / CRE	A ₁ , A ₂ , A ₃ , C ₂ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data
			<ul style="list-style-type: none"> • Mission Number 				Both Platform/Gnd
			<ul style="list-style-type: none"> • Call Sign 				LOS
			<ul style="list-style-type: none"> • Aircraft Type (specific – i.e. B-1B, F-15E, C-17, KC-135, etc.) 				
			<ul style="list-style-type: none"> • Number of Aircraft (if reporting for a flight / formation) 				
			<ul style="list-style-type: none"> • Location (i.e. PPLI) 				
			<ul style="list-style-type: none"> • Heading 				
			<ul style="list-style-type: none"> • Speed 				

13	A/R: 2, 3, 4	Friendly Ground Positions	<ul style="list-style-type: none"> • Identification 	CAF/Joint C2; ISR	Airlift acft; ISR; MAF C2	B, D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data
	<ul style="list-style-type: none"> • Location 		Both Platform/Gnd				
			LOS				
14	A/R: 2, 3, 4	Ground/Surface Control and Coordination Measures (ground axis of advance, Forward Edge of the Battle Area (FEBA), Forward Line of Own Troops (FLOT), etc.)	<ul style="list-style-type: none"> • Identification/Name 	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data
	<ul style="list-style-type: none"> • Type 		Both Platform/Gnd				
	<ul style="list-style-type: none"> • Establishing/ Controlling Unit • Effective Time(s) • Location • Size • Restrictions • Instructions 		LOS				
15	A/R: 2, 3, 4	Hostile Aircraft (aircraft identified as hostile)	<ul style="list-style-type: none"> • Identification (track number, target number, etc.) 	CAF C2; ISR	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2	B, D, F ₃ , F ₄ , G, H, I	SA data
	<ul style="list-style-type: none"> • Aircraft Type (specific – i.e. MIG-29) 		Both Platform/Gnd				
	<ul style="list-style-type: none"> • Number of Aircraft (in flight/formation) • Nationality (if multiples are possible) • Location • Altitude • Heading • Speed • Weapons • specific withdrawal headings and altitudes to escape enemy fighter detection or engagement • Real-time Electronic Order of Battle (EOB) and Electronic Warfare (EW) and off-board near real-time threat information • Systems / On-Board Capabilities • Fuel Remaining / Endurance Estimate • Friendlies Targeted (if applicable) • Activity • Intentions / Probable Course of Action 		LOS				
16	A/R: 2, 3, 4	Hostile/Threat Ground Entity	<ul style="list-style-type: none"> • Identification 	CAF/Joint C2; ISR; LZ/DZ Party	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₂ , A ₃ , B, C ₁ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data
	<ul style="list-style-type: none"> • Nationality 		Both Platform/Gnd				
	<ul style="list-style-type: none"> • Location • Type (i.e. Mobile Units, Troop Concentrations, etc) • Subtype (i.e. SA-8) • Weapons (if not conveyed by subtype) • Weapons range • Electronic capability (i.e. radar, jamming, etc)(if not conveyed by subtype) • Activity • Intentions/probable course of action¹⁴ 		Both BLOS/LOS				
17	A/R: All	In-Transit Visibility (ITV)	<ul style="list-style-type: none"> • Payload information 	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft	A ₁ , A ₂ , A ₃	C2 data
	<ul style="list-style-type: none"> • Cargo 		Both Platform/Gnd				
	<ul style="list-style-type: none"> • Passengers • Equipment 		Both BLOS/LOS				
18	A/R: All	Maintenance	<ul style="list-style-type: none"> • Flying Hours 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data
	<ul style="list-style-type: none"> • Number of Landings 		Both Platform/Gnd				
	<ul style="list-style-type: none"> • LRU Fault Codes • Landing Gear Cycles • Life Usage (on all aircraft components) • Engine trending and diagnostic data • Aircraft structural data (aircraft weight, fuel load, strain gauge readings, etc.) • Fuel Load • Alpha Status (number of faults and fault codes) • Automatically download historical aircraft systems data • Report aircraft condition monitoring information • Transmit aircraft condition information to identify maintenance issues or servicing delays 		Both BLOS/LOS				
19	A/R: 1	On/OffStation Notice	<ul style="list-style-type: none"> • Mission Number 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃ , G, H	C2 data
	<ul style="list-style-type: none"> • Status (on or off station) 		Ground C2				
	<ul style="list-style-type: none"> • Effective Time(s) (if not immediate) 		Both BLOS/LOS				
	<ul style="list-style-type: none"> • Intentions 						

20	A/R: All	Passenger	<ul style="list-style-type: none"> Number of pax 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data
			<ul style="list-style-type: none"> Number deplaning at next stop 				Both Platform/Gnd
			<ul style="list-style-type: none"> Number of DVs 				Both BLOS/LOS
			<ul style="list-style-type: none"> Report actual passenger information. This includes reporting unused capacity (e.g., available seats, litters) 				Contributes to ITV
21	A/R: All	Payload	<ul style="list-style-type: none"> Type of cargo 	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data
			<ul style="list-style-type: none"> Hazardous cargo, if applicable 				Both Platform/Gnd
			<ul style="list-style-type: none"> Number of pallets 				Both BLOS/LOS
			<ul style="list-style-type: none"> Report actual payload (e.g., cargo, fuel) information. This includes reporting unused capacity (e.g., pallet positions, fuel available for offload) 				Contributes to ITV
22	A/R: 2, 3, 4	System Status	<ul style="list-style-type: none"> Total Fuel 	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft; ISR; Receivers; DZ/LZ Party	A ₁ , A ₂ , B, C ₁ , C ₂ , D, E, F ₃ , F ₄ , G, H?	C2 data
			<ul style="list-style-type: none"> Destination Reserve Fuel 				Ground C2
			<ul style="list-style-type: none"> Loiter Mean Fuel Burn Per Hour 				Both BLOS/LOS
			<ul style="list-style-type: none"> Equipment/System Status 				
			<ul style="list-style-type: none"> RTB 				
			A/R unique items:				
			<ul style="list-style-type: none"> Total Fuel Off-Load Available from Tanker(s) (lbs) 				
23	A/R: 4	Tactical Airdrop/Airland Control	<ul style="list-style-type: none"> DZ/LZ Identification 	MAF C2; Airlift acft; DZ/LZ Party	MAF C2; Airlift acft; DZ/LZ Party	A ₁ , A ₂ , A ₃ , B, C ₁ , C ₂ , G, H	C2 / SA data
			<ul style="list-style-type: none"> DZ/LZ Location 				Both Platform/Gnd
			<ul style="list-style-type: none"> New point of impact coordinates 				Both BLOS/LOS
			<ul style="list-style-type: none"> DZ/LZ Marking 				
			<ul style="list-style-type: none"> Confirmation and authentication of DZ and drop information 				
			<ul style="list-style-type: none"> Load information in the dynamic tactical area 				
			<ul style="list-style-type: none"> Tactical arrival/SPIN procedures 				
			<ul style="list-style-type: none"> Communications Check Point (CCP) 				
			<ul style="list-style-type: none"> Cleared to Drop 				
			<ul style="list-style-type: none"> Abort Code 				
			<ul style="list-style-type: none"> Type of drop 				
			<ul style="list-style-type: none"> Initiation point 				
			<ul style="list-style-type: none"> Point of impact 				
			<ul style="list-style-type: none"> DZ/LZ size 				
			<ul style="list-style-type: none"> Heading 				
			<ul style="list-style-type: none"> Altitude 				
			<ul style="list-style-type: none"> DZ/LZ elevation 				
<ul style="list-style-type: none"> DZ winds-threshold 							
<ul style="list-style-type: none"> DZ ceiling/visibility 							
<ul style="list-style-type: none"> Time and results of air drop events and mission event information 							
24	A/R: 2, 3, 4	Unknown/Neutral Aircraft	<ul style="list-style-type: none"> Identification 	CAF C2; ISR	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	B, C ₂ , F ₃ , F ₄ , G, H	SA data
			<ul style="list-style-type: none"> Aircraft Type (specific – i.e. Boeing 747) 				Both Platform/Gnd
			<ul style="list-style-type: none"> Number of Aircraft (in flight/formation) 				LOS
			<ul style="list-style-type: none"> Nationality 				
			<ul style="list-style-type: none"> Location 				
			<ul style="list-style-type: none"> Altitude 				
			<ul style="list-style-type: none"> Heading 				
			<ul style="list-style-type: none"> Speed 				
			<ul style="list-style-type: none"> Weapons 				
			<ul style="list-style-type: none"> Systems/On-Board Capabilities 				
			<ul style="list-style-type: none"> Fuel Remaining/ Endurance Estimate 				
			<ul style="list-style-type: none"> Activity 				
			<ul style="list-style-type: none"> Intentions/Probable Course of Action 				
	<ul style="list-style-type: none"> Specific withdrawal headings and altitudes to escape enemy fighter detection or engagement 						

25	A/R: All	Weather	<ul style="list-style-type: none"> Applicable Area (target area – LZs, DZs, and A/R tracks, recovery base, etc.) Cloud Cover (%) Cloud Height(s) Winds (surface and aloft as applicable) Contraill Altitudes Precipitation Significant Weather (thunderstorms, etc.) Altimeter Visibility Altimeter Moon Rise Moon Set 	MAF C2; CAF/Joint C2; Airlift acft; Tanker acft; ISR; Receiver	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , A ₄ , B, C ₁ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H?	C2 / SA data
			Both Platform/Gnd				
			Both BLOS/LOS				
26	A/R: All	Mission Tasking, Planning & Scheduling (MTP&S)	<ul style="list-style-type: none"> Request and/or receive mission and mission guidance information and changes to that information. This includes for example: <ul style="list-style-type: none"> General mission information; Mission schedule/ itinerary; Payload (Planned cargo, passengers, patients) Airdrop taskings; Air refueling information; Mission and controller remarks; Contact information; airspace, diplomatic clearances; Aircraft and aircrew information; Permissions (e.g., Prior Permission Required (PPRs, Positive Launch, Secure Launch, Waivers)); Mission advisories; Computer flight plans; Flight plan filed with ATC; Changes to computer and ATC flight plans; Weather briefing; threat briefing; Notices to Airmen (NOTAMs); Flight manager-produced aircrew departure papers; C2 manager notes; etc. Directions to divert to another operating location, which may be an air event location, such as air refueling track, drop zone, etc Arrival location and mission support information (e.g., hazardous parking required, parking spot location, aircraft servicing, customs, passenger service, payload and special handling information). Missions dynamically adjusted for threat mitigation Maintenance status, parking Force protection policies Special Instructions (SPINS) Tactics recommendations Aircraft performance and limitations information 	MAF C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , A ₄ , H	C2 data
			Both Platform/Gnd				
			Both BLOS/LOS				
27	A/R: 2, 3, 4	Air Force Airborne Network / Joint Aerial Layer Network (AFAN/JALN) enhancement	<ul style="list-style-type: none"> Receive and relay information to other MAF and CAF aircraft. Relay point for warfighters on the ground. 	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	B, C ₂	SA data
			Platform/Aircrew				
			LOS				
28	A/R: All	Aircrew Information	<ul style="list-style-type: none"> Report aircrew information Report aircrew currency items completed during the sortie Review and score Aviation Operational Risk Management (AvORM) and update the AvORM application 	MAF C2; Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃ , A ₄	C2 data
			Both Platform/Gnd				
			Both BLOS/LOS				
29	A/R: All	Mission Team Information	<ul style="list-style-type: none"> (AE only) Provide ability for continuous transmission of patient data/status, and feedback from ground based providers for consultation requirements Other Mission Team IERs TBD NOTE: MAF aircraft will provide the basic network permissions and DODIN/JALN connectivity 	Mission Team; Mission Team C2	Mission Team; Mission Team C2	E, I	C2 data
			Mission Team				
			Both BLOS/LOS				

Appendix C: Consolidated Information Exchange Requirement Table

IER	Phase	Description	Producer	Consumer	Needline	Remarks	Comm System Type	Synchronous / Asynchronous
1	Alft & A/R: All	Acknowledgement (indicates a message or order has been received and the receiver will or cannot comply)	Airlift acft; Tanker acft; ISR; Receivers; MAF C2; CAF/Joint C2	MAF C2; CAF/Jt C2	A ₁ , A ₂ , A ₃ , B, D, G, H	C2 data	Both BLOS/LOS	Synchronous
2	Alft & A/R: All	Air Tasking Order (ATO)	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, D, F ₃ , H	C2 data	LOS	Synchronous
3	Alft: 4 A/R: 5	Airfield Status	MAF C2	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , C ₁ , D, F ₃	C2 data	Both BLOS/LOS	Synchronous
4	Alft: All A/R: N/A	Airlift Msn Status	Airlift acft; MAF C2	Airlift acft; MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Synchronous
5	Alft: N/A A/R: All	Tanker Mission Status	Tanker acft	MAF C2; CAF/Joint C2; ISR; Receivers	A ₁ , A ₂ , A ₃ , B, C ₂ , F ₁ , F ₃ , G, H	C2 data	Both BLOS/LOS	Synchronous
6	Alft: N/A A/R: 2, 3, 4	Tanker/Receiver Link- up & Coordination	Tanker acft; Receiver	Tanker acft; Receiver	B, C ₂ , D, F ₄	SA data	LOS	Synchronous
7	Alft: 2, 3, 4 A/R: 1, 2, 3, 4	Airspace Control and Coordination Measures (routes, engagement zones, Airspace Coordination Areas (ACA, etc.)	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data	Both BLOS/LOS	Synchronous
8	Alft & A/R: All	Emergency Situation (in- flight emergency, downed pilot, etc.)	Airlift acft; Tanker acft; ISR; Receivers	Airlift acft; Tanker acft; ISR; Receivers	A ₁ , A ₂ , B, C ₂ , D, F ₃ , F ₄ , G, H	C2 / SA data	Both BLOS/LOS	Synchronous
9	Alft: 3, 4 A/R: 2, 3, 4	Execute/Terminate Command (used to execute or terminate a plan or action. Includes engagement/abort orders, declaration or termination of hostilities, etc.)	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 data	Both BLOS/LOS	Synchronous
10	Alft & A/R: All	Flight Hazards	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	C2 / SA data	LOS	Synchronous
11	Alft & A/R: All	Flight Routing	MAF C2; CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , C ₁ , D, F ₃ , G, H	SA data	LOS	Synchronous
12	Alft: 3, 4 A/R: 2, 3, 4	Friendly Aircraft (aircraft identified as friendly)	CAF/Joint C2; ISR; Individual acft	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2; WOC / AMS / CRE	A ₁ , A ₂ , A ₃ , C ₂ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data	LOS	Synchronous
13	Alft: 3, 4 A/R: 2, 3, 4	Friendly Ground Positions	CAF/Joint C2; ISR	Airlift acft; ISR; MAF C2	B, D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data	LOS	Synchronous

14	Alft: 3, 4 A/R: 2, 3, 4	Ground/Surface Control and Coordination Measures (ground axis of advance, Forward Edge of the Battle Area (FEBA), Forward Line of Own Troops (FLOT), etc.)	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receivers; MAF C2	A ₁ , A ₃ , D, F ₃ , G, H	SA data	LOS	Synchronous
15	Alft: 3, 4 A/R: 2, 3, 4	Hostile Aircraft (aircraft identified as hostile)	CAF C2; ISR	Airlift acft; Tanker acft; ISR; Receiver; MAF C2; CAF/Joint C2	B, D, F ₃ , F ₄ , G, H, I	SA data	LOS	Synchronous
16	Alft: 3, 4 A/R: 2, 3, 4	Hostile/Threat Ground Entity	CAF/Joint C2; ISR; LZ/DZ Party	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	A ₁ , A ₂ , A ₃ , B, C ₁ , D, F ₁ , F ₂ , F ₃ , F ₄ , G, H	SA data	Both BLOS/LOS	Synchronous
17	Alft & A/R: All	In-Transit Visibility (ITV)	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
18	Alft & A/R: All	Maintenance	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
19	Alft: 1 A/R: 1	On/OffStation Notice	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃ , G, H	C2 data	Both BLOS/LOS	Asynchronous
20	Alft & A/R: All	Passenger	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
21	Alft & A/R: All	Payload	Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃	C2 data	Both BLOS/LOS	Asynchronous
22	Alft: 4 A/R: 2, 3, 4	System Status	Airlift acft; Tanker acft	MAF C2; Airlift acft; Tanker acft; ISR; Receivers; DZ/LZ Party	A ₁ , A ₂ , B, C ₁ , C ₂ , D, E, F ₃ , F ₄ , G	C2 data	Both BLOS/LOS	Asynchronous
23	Alft: 4 A/R: N/A	Tactical Airdrop/Airland Control	MAF C2; Airlift acft; DZ/LZ Party	MAF C2; Airlift acft; DZ/LZ Party	A ₁ , A ₂ , A ₃ , B, C ₁ , C ₂ , G, H	C2 / SA data	Both BLOS/LOS	Synchronous
24	Alft: 3, 4 A/R: 2, 3, 4	Unknown/Neutral Aircraft	CAF C2; ISR	Airlift acft; Tanker acft; ISR; Receiver; MAF C2	B, C ₂ , F ₃ , F ₄ , G, H	SA data	LOS	Synchronous
25	Alft & A/R: All	Weather	MAF C2; CAF/Joint C2; Airlift acft; Tanker acft; ISR; Receiver	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , A ₄ , B, C ₁ , D, F ₁ , F ₂ , F ₃ , F ₄ , G	C2 / SA data	Both BLOS/LOS	Asynchronous
26	Alft & A/R: All	Mission Tasking, Planning & Scheduling (MTP&S)	MAF C2	Airlift acft; Tanker acft; ISR; Receiver	A ₁ , A ₂ , A ₃ , A ₄ , H	C2 data	Both BLOS/LOS	Asynchronous
27	Alft: 3, 4 A/R: 2, 3, 4	Air Force Airborne Network / Joint Aerial Layer Network (AFAN/JALN) enhancement	CAF/Joint C2	Airlift acft; Tanker acft; ISR; Receiver	B, C ₂	SA data	LOS	Synchronous
28	Alft & A/R: All	Aircrew Information	MAF C2; Airlift acft; Tanker acft	MAF C2	A ₁ , A ₂ , A ₃ , A ₄	C2 data	Both BLOS/LOS	Asynchronous
29	Alft & A/R: All	Mission Team Information	Mission Team; Mission Team C2	Mission Team; Mission Team C2	E, I	C2 data	Both BLOS/LOS	Synchronous

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE (DD-MM-YYYY) 03/06/2022	2. REPORT TYPE Graduate Research Paper	3. DATES COVERED (From - To) July 2021 - June 2022
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4. TITLE AND SUBTITLE Prioritizing Mobility Air Force Airborne Information Exchange Requirements	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S) Vanderpol, Cody Maj	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/EN) 2950 Hobson Way Wright-Patterson AFB OH 45433-7765	8. PERFORMING ORGANIZATION REPORT NUMBER AFIT-ENS-MS-22-J-057
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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Mobility Command Commander's Innovation Group Col Bradley Rueter Bldg 1600 402 Scott Dr, Scott AFB, IL 62225 bradley.rueter@us.af.mil	10. SPONSOR/MONITOR'S ACRONYM(S) AMC
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A. Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES
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14. ABSTRACT
The fundamental issue that both the Air Force and Joint Community wrestles with is Mission Assurance. This research takes the comprehensive listing of airborne Information Exchange Requirements found in the AMC Global Secure Command and Control Air to Ground Communications Capabilities Based Assessment and seeks to characterize and prioritize them with regards to Mission Assurance. An IER Framework is presented to help inform the communication gaps and describe what type of decisions are required during Mission Type Order execution. This specifically assists in Risk Guidance based on what type of decisions the Aircraft Commander may have to execute.

15. SUBJECT TERMS
Airborne Information Exchange; Mission Assurance; Mission Type Orders; Risk Guidance; Agile Combat Employment;

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON	
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dr. Jeffery D. Weir, AFIT/ENS	
U	U	U	UU	52	19b. TELEPHONE NUMBER (Include area code) (937) 255-3636 x4523 Jeffery.Weir@afit.edu	